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# ***JPRS Report***

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# **Science & Technology**

***USSR: Engineering &  
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# Science & Technology

## USSR: Engineering & Equipment

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12 September 1989

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### Waiting for the 'Turtle'; Seismic Activity Increasing

18610513 Moscow STROITELNAYA GAZETA  
in Russian 13 May 89 p 2

[Article by A. Sabirov, "Waiting for the Turtle. New Means Are Required to Study Earthquakes." (Tatar ASSR)]

[Excerpts] [Passage omitted] The earthquake of 23 September in East Tataria is not the only one in recent years and will not be the last. A new shock, for example, occurred already on the following day, 24 September, and was stronger than the previous one. And before that, the ground swayed in the years of 1982, 1983 and 1985. This gave the basis to the specialists of "Tatneft" and "Tatneftegeofizika" for concluding that seismic activity in the region is increasing.

"No observations have been made here," stated N. Gatiatullin, Deputy Chief of the Geological Department of the "Tatneft" Association. Although archival materials indicate that quakes in the region of the present Almetyevsk occurred in 1866 and 1914, in 1914 the shock reached six points.

Such seismic activity in itself requires special investigations. But there are also other serious reasons for alarm: the section in which shakes occurred noticeably in recent years is the territory in which, for dozens of years, petroleum was pumped from the Romashkinsk Petroleum Deposit. After the 1982-1983 shocks, cracks appeared on some buildings in Almetyevsk.

Scientists from various cities in the country participated in a special meeting at "Tatneft" and expressed the opinion that the causes of the underground shocks are most likely tied directly to the production of great quantities of petroleum and the pumping of water into the seams. In other words, the quakes are of a technical-genetic nature.

The "Tatneft" Production Association jointly with the Earth Physics Institute of the USSR Academy of Sciences developed a "Tatneftegeofizika" investigation program and expressed readiness to organize a special seismic party. But there the matter came to a standstill.

For three years the leaders of both associations have been trying to obtain seismic stations directly from the USSR Minister of the Petroleum Industry, by the irony of fate named "Turtle." While waiting for them, seismologists could make observations from only one point. The shock of 20 September 1986 was not recorded because the equipment was undergoing preventive maintenance.

But from 24 September 1986 to January 1987, 31 shocks were recorded. The times of seismic activation in 1982 and 1986 coincide with the periods when volumes of pumping liquids into the strata exceeded considerably the volumes removed.

"This characteristic was also traced subsequently when using the "Turtle," stated I. Isakov, chief of the seismological party of the "Tatneftegeofizika."

At the request of the Almetyevsk Gorispolkom the special republic commission investigated the condition of the buildings in which local cracks has appeared after the underground shock of 1982. At that time it was established that they were not dangerous.

How will the buildings fare if the shocks repeat themselves? N. Gilmanov, Deputy Chairman of the TASSR Gosstroy, stated that the question of the shocks being repeated was then not considered in general.

"Perhaps construction norms adopted in the region need to be reviewed," continued N. Gilmanov. So far, housing is being built in Almetyevsk which is not designed for seismic activity. Perhaps a new seismic map of the region is needed."

The last shock occurred on 19 January of this year. This happened about 30 kilometers from Almetyevsk and not too far from the Tatar AES being built at present.

The fact remains: so far no republic or scientific organization is connected to the investigations of seismic activity and its interrelation to petroleum production territories where they should be conducted—in the Bashkiria, Orenburg and Kuybyshev oblasts.

What will be the price of the delay?

Just when this material was written, information arrived about a new quake in Tataria. On 17 April at 5 o'clock, 22 minutes shocks measuring from 4 to 6.5 were recorded at Elabug. [passage omitted]

### Severe Drawbacks of Nuclear Power Discussed

18610447 MOLOD UKRAYINY in Ukrainian 15, 16, 18, 19 Feb 89

[Article by Candidate of Juridical Sciences, Docent, MVD SSSR [the USSR Ministry of Internal Affairs] Academy, B. Kurkin under the "AES: Pros and Cons" rubric: "Time of Peaceful Atom"; first paragraph is MOLOD UKRAYINY introduction] [15 Feb 89 p 4]

[Text] How should our country's nuclear power industry develop? This is the question that sounds especially keenly after the Chernobyl disaster. According to the most modest calculations, R8.5 billion has been spent to eliminate the consequences of the disaster, whereas all AES in our country made a R2.5 billion profit over all years of operation. The numbers force one to stop to think again of problems of ecological and economic efficiency of today's AES.

#### Burial of Waste

When discussing AES problems, specialists all over the world first of all pay attention to economic efficiency, ecology and safety of nuclear power. But nuclear power

is only "ecological" inasmuch as it is "safe" and "safe" and "ecological" inasmuch as it is "economically inefficient". We shall examine this problem in greater detail, beginning with studying the economic efficiency, ecology and safety of the entire fuel cycle.

The cycle includes ore mining and uranium extraction, conversion of raw materials into ready-for-use nuclear fuel (uranium concentration), efficient fuel utilization in nuclear reactors, transportation and chemical regeneration of spent fuel, cleaning it from radioactive waste and impurities, and then the eternal burial of the waste. The cycle also includes possible return of regenerated uranium and plutonium accumulated in spent fuel back into the AES fuel system. We shall note at the onset that this entire complex cycle is very expensive, extremely energy-consuming and absolutely nonecological.

The very mining of radioactive ore (as incidentally any other branch of the mining industry) cannot but affect the environment.

When mining uranium ore, land is taken out of the agricultural cycle, the territory's hydrology changes, and soil, water and atmosphere are polluted with natural radionuclides. Note that these radionuclides have a long half-life and create a hazard of irradiating the population for hundreds and thousands years to come.

By the way, for nuclear fuel used in some reactors, concentrated to 3.6-4.4 percent, with uranium-235 contents in the dump equal, for instance, to 0.2 percent, the waste is approximately equal to 90 percent of the entire mass of processed uranium.

Waste is also high at the uranium concentration stage. As to the cost of this process, with current world-market prices one can compare uranium concentration expenses to the cost of natural uranium used for producing concentrated uranium.

The initial stage of the fuel cycle ends with manufacturing of fuel elements and fuel assemblies from nuclear fuel.

Spent nuclear fuel must be reloaded into a so-called retention pond located in the reactor room. It stays there for several decades. Such long retention is needed in order to reduce radioactivity.

As approximately 180 tons of fuel is charged into a 1000 MW reactor, approximately 300 tons of radioactive waste accumulates at the AES territory over five years of operation of just one power generating unit.

Let us now talk of another stage of a nuclear fuel cycle, chemical recycling of spent fuel.

Radiochemical enterprises now in operation worldwide have low production capacity. A number of important technological processes, and particularly such as waste deactivation, are still in the research, experimental and engineering development stage. Studies conducted by specialists from the IAEA and European Atomic Energy

Community proved that by the year 2000 approximately 200,000 tons of uranium will accumulate worldwide, while it only would be possible to recycle 25 percent of it. Thus, an unnatural situation has formed, wherein waste heaps are growing, while one has not yet developed a chemical technology needed for their recycling and people's safety. And long-term storage and burial of spent fuel without recycling is extremely dangerous. But even chemical waste recycling does not solve all problems. The thing is that the waste is shipped to a chemical recycling plant in containers, by rail, auto or water transportation. The containers are hauled in specially designed railcars, autotrailers and by amphibious means. Loaded containers weigh in between 30 and 110 tons. Their cost can be as high as \$500,000, up to \$1.5 million with a special car. The coefficient of utilization of expensive transportation means is low, and the capital investment is tangible. The containers must meet stringent requirements, first of all reliable biological shielding from ionizing radiation and leakproofness in emergency situations. And when one stops to think of what is happening on our railroads, when sometimes it seems that the guerilla war on rails is not over yet, one can't help worrying whether all hundred-ton containers can get safely to the burial ground. The very shipment of nuclear fuel or waste poses a direct threat to the environment, even without an accident.

Let us now talk about the final stage of the cycle, which is at the same time the main problem of the nuclear power industry—the eternal burial of waste.

At present, no expert can tell for sure where and how to store radioactive waste, which will remain hazardous to human health for hundreds of millenia. The AES construction boom that began in the 1960s concentrated the public's attention on the problem of reactor safety. And only from time to time did specialists remind of an unsolved and, in the opinion of many, unsolvable problem of radioactive waste storage.

Academician P.L. Kapitsa considered burial of radioactive slags to be the most complicated mission of the nuclear power industry. The most appropriate conditions for waste burial can only be provided in continental geological formations, such as hundreds of meters plus-deep thick granite, gneiss and basalt rock. A loss of leakproofness by a container or an accident in the ventilation system pose a threat of a disaster; and when one takes into account the fact that for all practical purposes containers must be stored "forever", one has a lot to ponder over.

Radioactive waste buried in salt seams can become heated up to 200 plus degrees Celsius (due to residual heat). At this temperature salt seams decompose and release explosive gases. These gases lead to corrosion of steel and heat cracking of concrete containers. This is why one builds at burial sites a complex and expensive system for ventilation and removal of aggressive gases.

So what should one do with the waste, after all?

Of course, in principle it can be reconcentrated and converted to fuel. But during waste processing new "waste" is generated, which also must be buried forever. After "purified" plutonium is used in fast reactors (and it only can be used in these reactors), it will also generate waste, and its specific radioactivity will be tens and hundreds of times higher than that of thermal reactors waste.

And now the subject of cycle economic efficiency. According to calculations of Western specialists, waste recycling and burial comprises around 75 percent of the cost of all processes in the fuel cycle. This alone makes nuclear power the most expensive type of power.

But burial of nuclear waste is not the only problem. The thing is, an AES that is at the end of its life is itself a kind of nuclear waste. Hence the problem of AES dismantling becomes extremely important.

AES life does not exceed 25-30 years, and then it must be dismantled. But this again is a science and production process in its own right, and a science and a production process, and with not yet well developed concepts at that. So how should one dismantle an AES? The simplest way is to take out spent fuel from the reactor, drain radioactive heat-transfer agent, shut down all systems and control the atmosphere inside the reactor room. In a word, put on a lock and wait until the radiation level decreases to acceptable levels. In the meantime, scientists and specialists will be figuring out what to do next. The question is how long one should wait. 50 years according to some calculations, 100 years according to others.

So, one will have enough ecological safety problems, generated during dismantling of nuclear power facilities, for a good hundred years. And according to Western experts, the cost of dismantling an AES will be equal to the cost of its construction.

At the same time the nuclear industry will also have to deal with giant masses of radioactive waste, when, somewhere in the 1990s, lives of the first big AES will be coming to an end and they will be shut down and dismantled.

American specialists stress that during the next 30 years more than 350 AES will be shut down worldwide. And no country is properly prepared for this.

According to specialists, as a result of AES dismantling as much waste will be generated as is generated over 25 years of its operation.

[16 Feb 89 p 4]

#### AES Siting

The next important problem, after waste burial and AES dismantling, is the problem of station siting.

When choosing an AES site, one must take into account sanitary, meteorological, seismic and hydrogeological

conditions of the region. One must also take into account the wind rose, atmosphere stratification, weather stability in the region and hydrogeological conditions.

We shall put it bluntly: none of the above preconditions was met when siting the Chernobyl AES, neither have they been nor are they being met when constructing all other Soviet stations. All Soviet AES are being built in the European part of the country, west of the line Volga - Volga-Baltic Canal, i.e. where approximately 60 percent of the country's population lives and the population density is highest. These are industrial and agricultural regions. Here, tremendous historical, natural and landscape values are concentrated. Of interest is the fact that powerful AES are located in the upper reaches of the main sources of drinking water, i.e. in places most important from the ecological standpoint.

Let us once more analyze the siting geography of our AES: Armenia, Lithuania, Leningrad, Kursk, Smolensk, Rovno, Kiev, Zaporozhye, Feodosiya, Saratov-on-Don, Voronezh, Gorky, Kazan, Kuybyshev, Saratov, Kalinin, Ufa, and now Arkhangelsk and Kostroma... The list is far from being exhaustive. New "nuclear powder kegs" are being hastily built. But now agencies cannot allude to "not conceiving the consequences of a possible accident". After Chernobyl the opinion of the majority of people who wrote letters to newspapers and competent bodies was unanimous: they recommended to build AES far away from densely populated regions of the country—in deserts, tundra and mountains.

The then-Chairman of the GKAE [State Committee on Nuclear Energy] A. Petrosyants explained why AES were built where they are: "One had to take into account the entire complex of problems—the region seismicity, availability of sufficient amount of water, a sufficiently well developed infrastructure, and certain conveniences for the station personnel and their families".

Let us begin with the requirement to take into account seismicity. It is this very factor that had not been taken into account when building the Rovno and Ignalina AES. Maybe "planning bodies" did not know that proximity of the Rovno and Ignalina AES to fractures of the European Plate would sharply increase requirements to seismicity? A lot of specialists contend that even a two-point earthquake in a region makes AES construction impossible.

An AES can only be built on soils that can withstand loads of 5 to 8 kg per sq. cm. For all practical purposes, this is rock. But the Rovno AES was built on carstic soils. As a result, cracks have developed in the AES building and several sand pits, which even suck in drilling equipment, have appeared on the site. Several "competent persons" were prosecuted. But it was still necessary to put up new millions of rubles in order to reinforce the soil.

By the way, carst formation can begin or intensify due to AES operation. Hot water an AES discharges intensifies undesirable geological processes.

One should not build AES close to underground water. Thus, if water is 3 to 6 m deep, one cannot build an AES. An ideal case is when the water-bearing horizon is an artesian pond. It is scientists' opinion that proximity to water-bearing horizons nearly resulted in another horrible tragedy.

AES cannot be built near tectonic fractures, slots, slips etc. For instance, in the USA AES are built not closer than 20-25 km from tectonic fractures and sill flow zones. Meanwhile the Armenian AES (a decision has been made recently to discontinue its operation - MOLOD UKRAYINY editor's note) is situated on exactly such fracture in a 9.5-point seismicity zone.

Granted, AES can be built on a sand soil and even, according to specialists, on any type of soil, but in this case one must drive piles that must reach crystalline rock. According to specialists' calculations, the depth of the crystalline rock in this case must not exceed 30-50 m. The granite foundation of the Middle-Russia Platform is 3-5 km deep, i.e. no piles can reach it. So, no matter what type AES are built in the European part of the country, all of them would be built on sand.

Is it possible that AES cannot be built in the European part of the USSR at all, if only from the engineering geology standpoint? Do competent persons ask themselves these question?

AES cannot be built near TES [thermal power plants] either.

But it is well known that for instance in Zaporozhye two "flagships" of the Soviet heat power industry are being built simultaneously—a 3,600 MW TES, one of the world's and USSR's most powerful, and the head experimental-model AES with VVER-1000 reactors. Who came up with such an idea? Probably, those who did not know or did not want to know negative ecological consequences of "combining" such facilities. It is known only all too well that at an AES moisture evaporates, which combines with aerosols generated in TES pipes. "Acid rains" result.

Similar situations are in Voronezh and in Volgodonsk, where the Rostov AES is being built at an accelerated pace. The only difference is that in addition to a powerful AES there is also a powerful GES [hydroelectric power plant] there. And is it possible that everything can be attributed to the fact that the AES and TES construction projects were managed by different Minenergo SSSR [the USSR Ministry of Power and Electrification] administrations?

A lot of AES, like the Leningrad and Ignalina ones (the latter one with the USSR's most powerful reactor RBMK-1500 and with its No 2 power generating unit already commissioned) were built in those very regions that have excessive energy supplies anyway, so one had to build power transmission lines to other regions at the same time the AES were under construction. In other

words, one loses 10 percent of electric power per thousand km of power transmission lines.

One of the most serious aspects in the entire epopee of AES siting in the USSR is the fact that they are being constructed on valuable chernozem, which we are destroying at hurricane speed. These lands constitute our main food potential. Another thing is that under the Soviet socioeconomic conditions a strange but absolutely natural situation has formed, when kolkhozes, which get "monetary compensation" from "Chernobyl agencies", find it profitable to get rid of their land. The amount of land declines, plan targets for kolkhozes are decreased, and due to the monetary pittance the kolkhozes become millionaires.

What kind of considerations governed our planning bodies when they were developing plans for the construction of the Crimea AES near Feodosiya? The thing is that in the case of an accident the country will lose a unique resort. In short, planting nuclear mines into our land is going on.

However, stresses Deputy Minister of Nuclear Power Industry [Minatomenergo] A. Lapshin, "it would be wrong to think that before the accident Minenergo did not attach importance to safety problems when selecting sites for construction of nuclear power plants. In doing so, one was strictly following State documents that regulate these problems" (apparently, the documents were followed, but AES (the Rovno AES and Atomash) were collapsing). He hastens to add that AES construction in unpopulated areas, which is insisted upon by a lot of "Pravda" and "Izvestiya" readers, will be "economically inefficient". "Won't the construction of an AES make the territory populated?", asks A. Lapshin. "At least 30,000 people live near a 6 million kW AES, a town in its own right". So, according to A. Lapshin, it does not matter where a reactor leaks—in the Taymyr Peninsula, in Kaliningrad or in Kalinin.

And Lapshin is echoed by Vice President of AMN SSSR [USSR Academy of Medical Sciences] L. Ilyin: "Speaking of moving AES to unpopulated regions, they simply will be economically inefficient", he stresses.

But new standards for AES siting are being developed. If one strictly follows these standards, AES could be pushed out somewhere close to the North Pole, but even there their safety is not guaranteed. And nobody is asking aloud: "What would we do if another Chernobyl happens, from which event, in theory, we have no guarantee?"

Who shall we then hold responsible? The Director and Party organizer? Shall we sue them to get compensation for the damage they caused and forever retain ill memories in our hearts, so our descendants draw lessons? Won't this all remind one of the ignorance of old times in the town of Glupov [Stupidville], when residents of the town situated in an abyss threw down Stepashka and

Ivashka, and then Porfishka and another Ivashka off the church tower, and then dispersed, without accomplishing a thing?

[18 Feb 89 p 2]

#### Ecology and Safety

From data on the environmental effect of radiation that is now being published in our country one can draw a conclusion that nuclear power is practically harmless. But all "pro-atom" articles do not take into account the so-called "accumulation" effect of AES radioactive emissions, i.e. accumulation of radioactive contamination in living organisms. They also do not take into account radioactive emissions of enterprises that receive and recycle nuclear fuel, nor do they take into account waste shipment expenses. They do not take into account the environmental effect of a number of long-lived radioactive nuclides either. The truth of the matter is, the environmental effect of nuclear power is even stronger than that of thermal power. Water demand for cooling AES reactors is extremely high. It is for a reason that AES are built near large water reservoirs. To cool a typical 4 million kW four-unit AES, a 60 square km lake is needed. If one uses cooling towers, like at TES, the cost of a nuclear power plant will increase substantially. And lakes cannot stand such thermal loads.

The sad fate of the Dryushkay Lake in Lithuania, next to which the Ignalina AES was built, and the Udomlya Lake in Russia (the Kalinin AES) is well known and instructive. All living organisms are rotting in these lakes-turned-swamps. The situation near the Leningrad AES is similar. The Gulf of Finland shore near the AES has become rushy, and the amount of sick fish (sprat and smelt) has increased sharply.

Thus, irreversible water losses (to evaporation) for cooling ponds for a 1 million kW power generating unit are approximately equal to 1 cubic m per second. If our nuclear power program, which plans to increase the capacity of our AES to 200 million kW by the year 2000, is fulfilled, irreversible water losses in the USSR will be approximately equal to 6 cubic km a year. This is the amount the Minvodkhoz [the USSR Ministry of Land Reclamation and Water Resources] was planning to divert from Northern rivers.

Interestingly enough, 90 percent of evaporated moisture falls in the form of atmospheric precipitation outside the 1000-km zone from the evaporation point. Taking into consideration AES locations and the prevailing wind direction, one can figure that the six cubic km of water mostly falls either outside the USSR or in overhumidified regions of the country.

Ecological problems during normal operation of nuclear power plants have become more or less clear. This has also been facilitated by publication of new data on the Chernobyl disaster.

"This is a terrible catastrophe", said Academician A. Sakharov in his interview for the German magazine "Spiegel". "None of the specialists in the nuclear power field anticipated that such thing could happen. A vast territory was subjected to strong radioactive contamination. Hundreds of thousands of people suffered. I was writing as early as 1956 on the effect of nuclear tests on the biosphere. However, the ecological situation that had formed after the Chernobyl disaster was a total surprise".

Could it be that Academician A. Sakharov somewhat exaggerates?

Well, let us do some calculations. It is well known that an RBMK-1000 reactor is charged with 180 tons of uranium. Uranium-235 constitutes 1.1 percent of the mass of uranium-238. In other words, a ton of fuel contains slightly over 10 kg of radioactive fragments, i.e. horrible radioactive waste, not counting the so-called "directed" radiation. This term denotes radioactivity of materials subjected to irradiation, such as external reactor structures and adjacent construction and technological facilities and equipment. The overall mass of these radioactive materials is several thousand tons.

So, if one is to believe official sources, 3.5 percent of fission and activation products that had accumulated in the ill-fated reactor of the No 4 power generating unit of the Chernobyl AES was released into the atmosphere... This is 63 kg of highly radioactive substances (and the above data were calculated as of May 6, 1986, although the reactor kept "burning", albeit at a slower rate, until May 10).

Let us compare: during the explosion of a one-kiloton atom bomb 37 g of fission products, i.e. the same type of substances that are generated by a nuclear reactor, are dispersed in the atmosphere.

The bomb that was dropped on Hiroshima had a 20 kiloton capacity, so 740 g of radioactive waste formed as a result of its explosion.

Now you compare 63 kg and 740 g.

In other words, the release of radioactive substances from the reactor of the No 4 power generating unit of the Chernobyl AES imeni V.I. Lenin was equal to the amount of waste generated as a result of the explosion of 90 atom bombs dropped on Hiroshima. But hardly anybody will be surprised if later on it turns out that the total release from the Chernobyl reactor was higher than 3.5 percent.

Besides, in Hiroshima the bulk of the radioactive material (except neutron- and gamma-radiation, which were acting momentarily), was lifted in the form of radioactive atoms and aerosols to the altitude of several km by powerful updraught air flows that had formed around ground zero (the well-known "mushroom") and dispersed in the atmosphere.

But in Chernobyl, radioactive materials settled around the AES. Thus, the scale of radioactive contamination in Hiroshima was smaller than in Chernobyl by a much higher factor than 90.

Still, it would be correct to say that one simply cannot compare Chernobyl and Hiroshima due to certain objective factors.

The overall release of fission products in Chernobyl (not counting noble radioactive gases) was equal to  $5 \times 10^7$  curies, which approximately corresponds to the 3.5 percent of the total amount of radionuclides in the reactor at the time of the accident.

For comparison: the release of iodine-131 during the 1979 Three-Mile Island accident, the second largest accident after the Chernobyl nuclear disaster, was equal to 15 (!) curies, i.e. three million times lower than in Chernobyl. And a typical nuclear explosion in the atmosphere (until 1963) was equal to  $15 \times 10^4$  curies of iodine-131, i.e. 333 times lower than in Chernobyl.

Despite these facts, Soviet physicians keep saying that as a matter of fact nothing terrible has happened: "It is clear now that actual irradiation doses turned out to be ten times lower" than was expected.

The Chernobyl tragedy came as a complete surprise to our specialists.

Leaders of our nuclear power industry do not preclude the fact that at some point in time another accident can happen at a "peaceful" nuclear facility. How else should one interpret the statement by Deputy Minister of Atomic Energy A. Lapshin that "it is impossible to make any technology accident-proof. The goal is not to totally eliminate all troubles, but to reduce them to a minimum"? Granted, Comrade Lapshin said that "it is completely in our power" to "eliminate accidents resulting in releasing radioactivity" and that "the entire cream of the crop of our nuclear science and technology participated in this work".

If one is to believe A. Lapshin, our specialists have developed and implemented an "absolute" system, which would not allow a catastrophe to happen.

Sometimes such "reorganization during the march" takes on a strange twist. Thus, in 1987 the State Committee for Nuclear Power [GKAE] signed an agreement with a West German company Kraftwerkunion to jointly build in the USSR a new type reactor, a 200-250 MW high-temperature helium-cooled reactor.

Of course, cooperation is a good thing. But there is cooperation and cooperation. The reactor in question has just been developed, and the West German community, as well as political and business circles, did not deem it possible (due to safety considerations) to test it in the FRG, but instead proposed to the GKAE to build one in the USSR. It is well known that we already have solid experience in eliminating AES catastrophes. This is

how it goes: we sell abroad ideas that we cannot implement in our country, while our partners propose that we implement ideas that they are afraid to implement in their respective countries.

Maybe in the last year or two we have made our nuclear power industry extremely safe?

But we find out from a local paper that, for instance, on October 21, 1987, a Kalinin AES [KAES] operator, "while switching operations that had already been mastered, began operating wrong valves. As a result of carelessness and negligence No 1 power generating unit was shut down, while the AES collective, stressed Party Committee Secretary V.N. Volkov, had been disgraced by this act in the entire Ministry, CPSU Central Committee and CPSU Raykom". And as a matter of fact, noted V.N. Volkov, "in May through October about everybody was shutting down our power generating units - a schoolboy, a female insulation worker, mechanics, operational workers etc."

And one would think this is not the end of it.

[19 Feb 89 p 3]

#### Cost of Nuclear Power

A sad fact is that nobody knows for sure how much it costs our State to generate electrical power at AES, and what are the expenses per 1 kW of AES capacity and 1 kWh of electric power. Even Chernobyl agencies do not. This does not mean, however, that it cannot be calculated.

In order to answer this question, we must ascertain, in addition to expenditures for producing fuel, at least the following data: the cost of an AES itself, as well as of "social and cultural facilities and establishments" to serve its personnel, operating expenses, the cost of station dismantling and burial, and the cost of nuclear waste recycling plants, determine expenses for protecting the environment from the AES and nuclear waste recycling enterprises, expenses for ensuring guaranteed operation etc.

Bluntly speaking, "nuclear oats" is not cheap nowadays. And this is in the case of "normal" AES operation. Another point is that today one probably can include other expenses in the cost of AES-generated electric power, such as medical treatment of disaster victims, including long-term treatment; expenses for moving the population from the disaster zone and paying appropriate compensation; and expenses for radioactive decontamination of the region.

And what should one do with industrial enterprises that happened to be situated in the disaster zone and with agricultural land? What about the loss of unique cultural valuables? Has anybody given any thought to what a disaster at the Leningrad AES, with its four Chernobyl-type reactors, could cost our country and world culture?



According to existing USSR standards, each AES must have a sanitary-protection zone, the so-called "observation zone". In this zone it is prohibited to build residential buildings, child care and medical and sanitation facilities, as well as industrial enterprises, food industry facilities, and ancillary and other structures that do not belong to the AES.

These zones take up vast land areas. Occupying valuable land, the State is forced at the same time to invest in the development of virgin lands in new areas, with all resulting social and economic consequences. When we build an AES 40 km away from a town, the cost of land at R20,000/hectare is about R10 billion. Not cheap! And this is before taking into account the cost of water.

In the last 15 years the cost of AES has increased fourfold. And for several reasons.

First of all, from time to time wholesale prices have increased 30 to 40 percent at a time; fuel also got more expensive.

Secondly, site preparation expenses and expenses for creating a developed infrastructure (main and access roads, housing etc.) have increased sharply. Thus, AES construction in Smolensk only began five years after the construction site had been prepared, 10 years in Kalinin.

Thirdly, in some cases, taking into account tangible opposition of local authorities, one had to incur unforeseen additional expenditures - build an object for the oblast or rayon, finance another object etc.

According to specialists' calculations, energy consumption for AES construction will be equal to 20 percent of electric power generated by the AES in 30 years, although as recently as 1975 these expenses were only equal to 10 percent, according to Western specialists.

Operating expenses at Soviet AES are high too. Thus, in the USSR it takes one man per 1 MW of electric power, while in the USA it only takes 0.2 man.

And this phenomenon of "population density" of Soviet AES is due not only to the low level of automation of the technological process, but also to the fact that there are no economic incentives for personnel reduction. On the contrary, in full compliance with Parkinson's law the management and supporting staff is being expanded. And the population of towns where they live is equal to 35-40 thousand, on the average.

And now let us ask ourselves where we shall "put" the population of these towns and what their occupation will be after AES will have been dismantled in 25-30 years. Nobody thinks of it and nobody includes the cost of these operations into the cost of power, because planning bodies only think until "tomorrow", or, to be more precise, until tonight. Thus, in two-three decades these towns will create extremely acute social, economic and demographic problems, which will have to be solved, whether one wants to or not.

When evaluating the economic efficiency of AES one probably should also take into account the amount of electric power that was used, for instance, for eliminating the consequences of the Chernobyl disaster.

It seems that the switch-over to the system of self-repayment and self-financing of enterprises (provided, of course, that it will be consistently implemented) will "put light" on the real cost of AES-generated electric power, because Minatomenergo will have to sell "its" electric power to Minenergo and thus compete with TES and GES of the latter.

Such competition does not promise anything good, so one can already foresee the strategies of the Ministry's behavior. The first strategy can be to sharply increase electric power rates in general, and the second one to shift the burden of extra expenses to Ministries and agencies that supplied equipment to Minatomenergo.

Both strategies have their drawbacks. The drawback of the first strategy is the overall increase of wholesale and retail prices all over the country. That of the second is the refusal of respective Ministries and agencies, whose position is not difficult to understand: why should they pay "for the rest of their lives" for things a lot of them have done "not of their own will", and even if some did it "of their own will", it is incomprehensible why they should be "paying off" "forever" for commitments that have been met long ago and do not follow at all from the original contract?

Of course, it is more profitable to develop alternative power and invest a portion of money freed up from nuclear power plants that were not built into new, ecologically clean power generating technologies.

This article only states the problem. During AES construction one must take into account at least five factors:

1. Economic factors (direct investment).
2. Environmental protection and nature-related factors (for instance, the loss of landscape, nature's losses, a larger number of foggy days, substantial water losses etc.).
3. Socioeconomic factors (socioeconomic changes in the process of project implementation, housing construction, creation of developed infrastructure, road construction, terrain "trampling" etc.).
4. Population's health and safety (moving facilities away from cities and other safety-ensuring measures).
5. Public opinion (population's willingness or unwillingness to have a nearby nuclear facility).

Taking into account these factors and ranking them is the most important element in the decision-making mechanism.

Judging from appearances, the entire science of decision-making criteria and taking into account and weighing

various factors is simply ignored in Soviet scientific and administrative circles, although works on the subject, which have been translated into Russian and published in ridiculously small quantities, immediately disappeared from bookstore shelves.

It is already an undisputed fact that due to its specific features nuclear power is an industry that complements the fuel and power balance, and only in cases when it is already impossible to increase the power capacity by any other means. And this absolutely economically inefficient and ecologically dangerous method cannot and must not become a regular method for solving energy-related problems, especially in our country.

One should seek solutions to our power problems along the lines of energy and resource saving, which is only possible if our entire business and economic life is "normalized".

But so far just this is obvious: under the current socio-economic conditions the development of power generation programs, including nuclear power programs, takes, mildly put, unexpected forms. The thing is we do not know how much power we really need, and we cannot find this out in principle. Power supply must be combined with the development of alternative energy sources. But this is a subject for another talk.

### Claims That Hair Loss in Sillamae Is Radiation Induced Disputed

#### Adamchuk Article

18610474 Tallinn *MOLODEZH ESTONII* in Russian  
4 Apr 89 p 3

[Excerpts from article by Yu. Adamchuk, senior scientific associate, Atomic Energy Institute imeni I. V. Kurchatov, under the rubric "Emergency Situation": "Alarm Without Panic"; first paragraph is *MOLODEZH ESTONII* introduction]

[Text] Our newspaper has already (see *MOLODEZH ESTONII* from 15 and 23 March 1989) told of the situation occurring in Sillamae where focal hair loss was discovered in several children. But on 24 March the newspaper *SOVETSKAYA ESTONIYA* published a deputy's inquiry by E. Grechkina in which she confirmed that the reason for the illness was radioactive radiation. We asked Yu. V. Adamchuk, a well-known scholar who has been involved with neutron physics and recording radiation for about 40 years, to explain the scientific essence of the problem. Yuriy Vladimirovich worked at nuclear reactors and high-power electron pulsing accelerators, and about 100 scientific works have come from his pen. In Sillamae he has conducted research as part of a commission of independent experts studying the situation that has arisen.

It is entirely understandable that the accident at the Chernobyl AES has created caution in the country with regard to the activity of all nuclear enterprises and even

a radiophobia, during which any outbreaks of the most diverse illnesses (especially mass illnesses) are immediately linked solely with the effect of radiation on the human organism. All other possible reasons are either brushed off or else relegated to an insignificant role. The damage from similar, if I may call them such, diagnostic methods cannot be overestimated. Hence the panic, passivity, and attempts to be cured by "everything and anything." Our resounding ecological ignorance also becomes apparent because of an inability to be objective in difficult situations. This is uniquely characteristic both on the scale of a single rayon or city and on the scale of the entire country: the misfortune of ecological ignorance is universal among us.

Today, as sometimes, we are very much in need of a sober view toward the problem; we need an approach based on scientific knowledge. Here I place hope in the deputies that we have just selected. They are precisely the ones who, with the trust of the people invested in them, should react quickly and delve carefully into everything that disturbs public opinion and provide qualified assessments of difficult situations and non-trivial events without excess emotional heat. Only then will we be saved from public ignorant pronouncements analogous to the statement of E. R. Grechkina in the 24 March 1989 issue of *SOVETSKAYA ESTONIYA* that linked the illness of children in Sillamae with increased radiation in the city as if this fact has been "strictly documented by the Chemical and Biological Physics Institute of the Estonian SSR Academy of Sciences."

Like any person with common sense, I fully share E. R. Grechkina's alarm at the very fact of the illness and I also understand that the cause of so unusual a disease in little children should be meticulously sought. However, because of E. R. Grechkina's inquiry, which was published 2 days before the elections (in which Elza Robertovna herself claimed a deputy's mandate), it turns out that everything is already clear. The diagnosis has been determined: the enterprise located next to the city, which excavates shale, has been blamed. I share Grechkina's alarm. And I can understand her pressure in the peak of a preelection fight, but I feel it necessary to explain the essence of E. R. Grechkina's errors, because of which she and society have fallen (I believe involuntarily) into error.

In actual fact, the reasons for the children's illness are not yet clear. Research is in full swing. However, one thing has already been established: radiation from radon, which is present in the buildings of the new microrayon is absolutely in no way involved. But I will speak of this in more detail later. Now I will note the following.

I would be in complete agreement with E. R. Grechkina if she had turned to the Estonian SSR Council of Ministers with a demand that the public be informed weekly regarding the works of the numerous commissions participating in explaining the true cause of the EE (by this I of course mean the emergency event!) and that the protocols and reports that have already been written

or that remain to be created on the subject be made public. I would also be in full solidarity with Elza Robertovna had she, for example, demanded that the Estonian SSR take more decisive measures to make the republic's ecological climate healthier—by providing a specific and distinct plan to eliminate various ecological violators: all smokestacks (this means those without the necessary filters), all dumping of wastes from the activities of all enterprises into streams (this means where the cleaning equipment is not operating in the required manner), and cessation of the use of all pesticides and chemical fertilizers that contaminate the soil and food-stuffs....If Deputy E. R. Grechkina had demanded all this from the Estonian SSR Council of Ministers, I would have been the first to express my agreement. Unfortunately, none of this was in her deputy's inquiry. Meanwhile, the ecological situation both in Estonia and throughout the entire country is becoming threatening.

It is precisely in the overall dynamics of the ecological situation on which something from outside is having a small effect and has caused an acute form of allergy that the causes of the illness of children in Sillamae should immediately be sought. The possibility that we have encountered some new infectious disease has still not been eliminated. When children became ill with a somewhat similar diagnosis in Chernovtsy, representatives of our institute also traveled to the scene. An examination of hair, saliva, blood, urine, stool, and skin covers did not reveal an increased content of toxic metals (for example, thallium, which was proposed) facilitating hair loss. The question has not yet been fully answered.

But radiation is in no way involved here! The copious falling out of hair in persons who receive high doses of radiation in accident situations does indeed occur, but only in the most severe forms of radiation sickness—and then, as a rule, 2 to 3 days before death....Because the suspicion (due to inadequate information and knowledge among a specific portion of the public) has arisen that radiation is responsible for the little children's balding and that the city of Sillamae stands atop uranium-containing (although in noncommercial concentrations) dictyonemic (so-called black) shale, the rayon's radiation conditions also had to be examined.

First, however, it is necessary to say a few words about radiation, irradiation, and doses. The republic's inhabitants should learn to deal with these problems in an intelligent manner. The situation regarding radiation conditions in Sillamae may turn out to be typical for other rayons of the Estonian SSR as well since "black" shales occupy a significant area, and it is mandatory that this be considered when designing new housing units.

I say again that nowhere in the world has hair loss due to the effect of nearby uranium mines or the effect of radon been recorded.

In conclusion I would like to mention trends in the development of nuclear power generation throughout the world. The whole world knows and discusses the

bulletins published by the International Atomic Energy Agency, which, for some reason, the Soviet mass media bypasses in silence. For some reason, our laborers do not know that, according to our estimates and those of the International Atomic Energy Agency, TETs dump 10 times more radioactivity into the atmosphere than do nuclear power plants (together with ash and aerosols escaping from stacks). Meanwhile, the relative share of nuclear power in the overall power production balance continues to grow steadily throughout the entire world and will continue to increase since natural fuels (oil, coal, gas) are being depleted everywhere and TETs operating on natural fuel are illicitly burning up the planet's oxygen and polluting it with unnecessary aerosols.

If the start-up of new nuclear power plants has virtually been halted today, it is because, after the large accidents in the United States and in our country, all countries are switching over to new, entirely safe new-generation reactors. Few people think that mankind still does not have any economic alternatives for producing electric power besides nuclear power, but thermonuclear units burning (in a nuclear sense) hydrogen and transforming it into neutral helium will only be launched into construction 50 to 100 years from now.

#### Response by Yu. M. Yevstigneyev

18610474 Tallinn MOLODEZH ESTONII in Russian  
4 Apr 89 p 3

[Response by Yu. M. Yevstigneyev, chairman of Sillamae Gorispolkom, written in response to article "Alarm Without Panic": "Yu. M. Yevstigneyev, Chairman of Sillamae Gorispolkom Includes Necessary Addendum"]

[Text] The first case of illness was discovered on 24 January 1989 by a local physician. By 20 February we already knew of six cases of alopecia. We then began mass examinations of children in the city and clinical monitoring of those affected. On 24 February Medical and Sanitary Station No 17 requested a toxicology specialist from the USSR Ministry of Health. On 28 February a commission arrived from the USSR Ministry of Health under the chairmanship of V. A. Sorokin, head of the treatment and preventive care service. The commission included physicians and scholars (about 25 persons)—from toxicology, immunology, radiology, hygiene, physics, biophysics....Some of them had already studied the problem in Chernovtsy.

On 6 March the commission chairman V. Sorokin and the head of Medical and Sanitary Station No 17 A. Novokhatskiy informed the deputy minister of health of the Estonian SSR and the chief epidemiologist of the republic's ministry of health of the commission's first conclusions and requested the timely organization of mass medical examinations of children in Kokhtla-Rarve, Narva, and Narva-Iyesuu. Sorokin sent L. Kar, ESSR minister of health, a telephone request that the necessary work be accelerated.

At the same time, the study of the possible reasons for the alopecia continued: the  $\gamma$ -background was measured and water, air, soil, food, and biological (hair, saliva, urine, nails) samples were taken. All of the data are now being studied in the respective institutes in Moscow, Leningrad, and Volgograd (where parallel independent studies using different methods are being conducted).

Although the commission working in Sillamae felt that there was no need to hospitalize the children, in accordance with the wishes of 17 parents, all were afforded the possibility of having the status of their sons' and daughters' health checked at the Pediatrics Institute of the Academy of Medical Sciences. The trip to Moscow was conducted at the government's expense. On 25 March the children returned feeling normal. They are attending kindergarten.

The course of the commission's work was discussed in regular broadcasts over local radio. Its members met with parents and the city's public, and they spoke at the labor collectives. All information may be received from a "hot line."

Comprehensive examination of all of the city's children revealed 50 cases of alopecia as well as one affected adult. It is remarkable that the "geography" of the illness encompassed pediatric preschool institutions throughout the entire city. The fact that seven parents from Kokhtla-Yarva who suspected that their children had also fallen ill recently referred to the commission merits special attention.

The main conclusion drawn by the commission to date excludes the  $\gamma$ -background and radon as causes of the alopecia. The research is continuing.

And finally. Back in 1985, the sanitary and epidemiological service of Medical and Sanitary Station No 17 approached the USSR Ministry of Health regarding the matter of the need to conduct scientific research work to develop specific hygiene recommendations during the construction of housing and social and cultural facilities in soil in which dictyonemic ("black") shale is present. Such work has been underway since 1986.

**Abstracts Appearing in 'Power Generation Construction'**

18610483 Moscow *ENERGETICHESKOYE STROITELSTVO* in Russian No 4, Apr 89 (signed to press 6 Apr 89) p 80

[Source supplied abstracts of articles appearing in "Power Generation Construction," April 1989]

[Text]

UDC 627.8.577.4

Some Aspects of World Practice of Construction of Hydroelectric Power Plants With Consideration of Environmental Protection. L. N. Toropov, pp 3-6

This article examines the prospects for the development of hydraulic power generation construction in our country. Consideration is given to the integrated solution of ecological and environmental protection problems on the basis of the existing experience in assimilating hydraulic power generation resources in other countries.

UDC 627.8.003.13

Economic Effectiveness of Hydraulic Power Generation Construction. I. I. Fayn, pp 6-10

The development of hydraulic power generation in the USSR is compared with that abroad. The factors determining the economic effect derived from the construction of GES, including savings of fuel and power resources and labor resources and the creation of new deep-water routes and territorial production complexes and industrial centers, are examined. The effect of GES and thermal power plants on the environment is analyzed. References 6.

UDC 621.311.21.003.13

Hydraulic Power Generation as Necessary Element of Country's Fuel and Power Generation Complex and Prospects for Its Development. B. L. Baburin, pp 10-14

This article examines the power generation and economic prerequisites of developing hydraulic power generation and the distinctive features of prospective hydraulic power generation construction throughout the country's rayons. An economic assessment is provided of the program for constructing GES and GAES as compared with an alternative version of developing power generation. The distinctive features of the effects of different versions of power generation construction on the ecology are noted.

UDC 621.311:577.4

Effect of Electric Power Plants on Environment. D. a. Ragozin, pp 14-19

The ecological aspects of the operation of different types of electric power plants are examined, including those using nontraditional energy resources.

UDC 627.81

Do We Need Water Reservoirs? A. Ye. Asarin, pp 19-22

This article presents a justification of the necessity of regulating the runoff of rivers as a principal method of satisfying the national economy's demands for water. The functions of water reservoirs are examined. The use of the water reservoirs of the Volzhsk-Kamskoye cascade by GES is analyzed separately. References, 10.

UDC 627.81

Flooding by GES Water Reservoirs: Real and Apparent Losses. Ye. N. Terentyev, pp 23-31

This article analyzes the scales of the dispossession of agricultural lands and the effect of these dispossessions on increasing the potential of agricultural production by saving live labor thanks to the operation of GES. The effect of the development of hydraulic power generation on production of the country's gross national product is examined. References 7.

UDC 621.311.21/157.1/5

Problems of Hydraulic Power Generation in Siberia. I. I. Fayn, pp 31-34

This article presents the results of estimates of the economic feasibility of installing the additional capacities at Siberia's GES that are not presently being used in the winter daily load graphs. The reasons for the interruption in the supply of power in Siberia in 1982 are analyzed. The use of the method of substantiating the installed capacity of a GES and estimating its economic effectiveness is demonstrated by way of the example of the design of the Katunki GES. References 3.

UDC 627.8.003.13

Socioeconomic Value of Katunki GES. I. G. Kantorovich, Zh. I. Nikulina, and I. I. Fayn, pp 34-39

This article examines the effect of the Katunki GES on the economic, social, and cultural development of the Altay kray and the Gorno-Altay administrative division. Such aspects as the increase in the region's electrification level, the introduction of electric heating, and the labor-saving effect of GES are analyzed. The following are examined: the social problems of the Altay people; the role of GES in strengthening the production infrastructure and solving the housing problem of the Gorno-Altay administrative division; the possibilities [passage omitted in source text]; and the [passage omitted in source text] effect of GES and alternative energy resources, including nontraditional small GES, unmanned micro-GES, and wind power generation units.

UDC 621.311.21:551.5

Change in Climate in Tailwater of Large Water Power Developments. V. A. Makarov, pp 39-42

The limitations of the effect of large GES on the climate change in their tailwaters is shown by way of the example of the Krasnoyarsk GES. The view that these changes have a dominant effect on the worsening of sanitary conditions and recreation conditions is rejected. The organization of representative and objective observations for a differentiated assessment of the factors that have a negative effect on the change in climate and sanitary conditions is proposed.

UDC 627.8.626.88

Water Development Works and Fishing Industry. B. S. Malevanchik, pp 42-44

This article examines effective engineering and organizational measures to preserve and breed fish in GES water reservoirs and to create spawning conditions for transient and semitransient types of fish.

UDC 621.311.621./791.752

Ways of Increasing Labor Productivity During Manual Arc Welding. I. N. Vornovitskiy, pp 44-46

Proposals are provided regarding implementing progressive technological decisions directed toward significantly increasing labor productivity during manual arc welding and reducing material consumption. The total yearly economic effect from introducing these technologies in

the organizations of the Soyuzenergmontazh is estimated at between 1.5 and 2 million rubles.

UDC 621.315.1

Introduction of New Mechanization Equipment and Reduction of Labor Expenditures in Electrical Network Construction. A. A. Zaikin and S. P. Kuvshinov, pp 46-50

This article examines the current status and prospects for the mechanization of electrical network construction. Data are presented regarding reducing labor expenditures when introducing new mechanization.

UDC 621.951.3.622

Boring Large Rocks With Ring-Shaped Drill. Yu. A. Kosobrodov, A. D. Dondukov, and V. A. Kuznetsov, pp 50-52

The design of a ring-shaped drill for drilling rocks with a hardness up to category 7 is presented, and the experience accrued in operating pilot industrial prototypes is analyzed. References 3.

UDC 621.311.2.002.2

Some Problems of Organizing Construction of TES and AES by Modular-Unit Method. M. M. Orlov, pp 52-55

The main trends in the development of the modular-unit method in the USSR Ministry of Power and Electrification are described. Measures to improve volume planning, design, and technological decisions geared toward the successful introduction of the modular-unit method into thermal electric power generation construction are presented. References 11.

UDC 62-83:621.313.2.045.001.5

## Industrial Robot With Combined External Magnetic System

18610494a Moscow MEKHAIZATSIYA I  
AVTOMATIZATSIYA PROIZVODSTVA in Russian  
No 4, Apr 89 pp 16-17

[Article by A. M. Litvinenko, candidate of technical sciences]

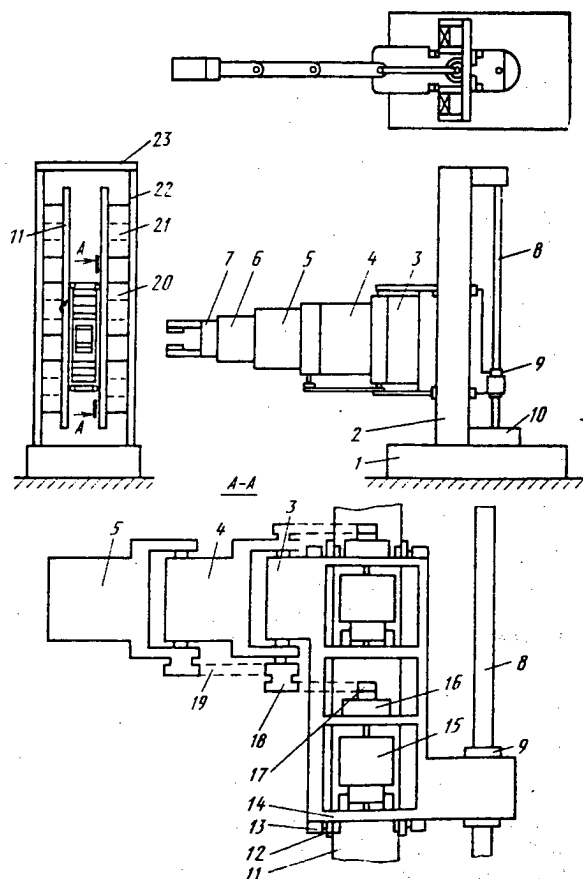
[Text] External magnetic systems<sup>1</sup> make it possible to sharply reduce the mass and overall dimensions of the electromechanical drive of industrial robot manipulators, which, given the same information indicators, results in an improvement of the drive's dynamics. This is achieved because the elements with the greatest mass, i.e., the magnetic field excitation systems, are located on immovable, stationary bases whereas the active current-conducting elements, i.e., the coils and armatures mounted on the manipulator, are included in the gap of the external magnetic systems during positioning or else are permanently located in the gap.

However, the significant weight reduction of the movable part of the industrial robot manipulator when external magnetic systems are used is frequently accompanied by an increase in the mass of the links that are mounted in a fixed position (the frames, the bases of the external magnetic systems, and the devices used to mount them). This frequently results in an undesirable consumption of construction materials and increases the specific quantity of metal used per structure.

The way out of this situation is to combine the functions of external magnetic systems as the source of the drive block's excitation field and purely structural functions, for example, guides for the elements. An angular-horizontal-type manipulator has been developed on the basis of this type of dual use of external magnetic systems, and its key characteristics have been determined in an actual mock-up.

The manipulator (see Figure 1) consists of a base (1) on which a column (2) (that represents the external closing yoke of the magnetic system) and a carriage (the first link) with a drive block with a second link (4) hinged to it are mounted in a fixed position. A third link (5) that includes a block (6) to rotate the wrist and gripper (7) is hinged to the latter. The carriage and the entire arm are raised and lowered by a lead screw (8) that interacts with a nut and is set into motion by the vertical drive. The nut is fastened on the projection of the carriage.

The carriage moves along guides (11) that simultaneously serve as the magnetic system's poles with the help of rollers (12) mounted in bearings (13). The carriage has crosspieces onto which are mounted bearings with armature shafts rotating in them. The armatures rotate reducing gears (16) with protruding shafts (17). Through a chain gear, the lower armature rotates the sprocket mounted on the third link, and a chain drive



(19) turns links (4) and (5) in a horizontal plane. The third link is connected with the second link by bearings. A sprocket that is connected with the shaft by protruding from the upper drive by a chain is fastened to the second link. The armatures have a collector and brushes. Coils (20) slipped on cores (21) connect the pole/guides (11) with the closing yoke (22). The right and left yokes are connected by cross pieces (23). Speed and position sensors (not shown in Figure 1) are also present.

The manipulator operates as follows. The drive (10) is switched on, and the carriage is lifted. Since the armatures are located in the magnetic system's gap, when voltage is fed to the brushes and collector, the armatures begin to rotate, and through reducing gears, the chain gears turn links (4) and (5). The carriage may also contain other drives that have been implemented according to an analogous scheme, with the motion being transmitted through hinges.

The magnetizing force in the magnetic system is created by coils (20) and cores. The flux passes through the coils and cores, terminals (guides (11)), an air gap, the closing yokes, and the cross pieces. Several coils have been mounted on both sides of the main gap to reduce the leakage flux.

The main technical and economic advantages of the industrial robot are as follows:

- the low specific metal content of the design and the high metal utilization indicators. This is because the external magnetic system becomes an organic component of the structure of the industrial robot's manipulator, becoming one of its component mechanical parts;
- the fact that the drive's size indicators remain virtually unchanged and the mass of the movable portion of the manipulator and drive block is significantly reduced because the magnetic system has been transferred to the base;
- a reduction in the mass and overall dimensions of the movable portion of the manipulator while its total mass and overall dimensions have been maintained. This increases the industrial robot's productivity because the time required for the starting and stopping process when the arm and drive block are raised and lowered is reduced.

The manipulator has been designed and manufactured at the Voronezh Polytechnic Institute and is being used in the training process.

Hollow armatures from a DPR-72 motor are used in the drive block. With a load-lifting capacity of 200 g (the same as that of the MP-9S pneumatic robot), the industrial robot described here possesses a higher maneuverability. This is because its gripper is capable of turning in a horizontal plane.

#### Footnotes

1. Litvinenko, A. M., "Electromechanical Robot," *MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA*, No 8, 1987, p 13.

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UDC 681.5.017

#### Night Vision System

18610494b Moscow *MEKHANIZATSIYA I AVTOMATIZATSIYA PROIZVODSTVA in Russian*  
No 4, Apr 89 pp 17-18

[Article by V. P. Kucheruk, candidate of technical sciences, and M. P. Aziyev and B. Yu. Sobolev, engineers]

[Text] The productivity of work done at night and under conditions of limited visibility or when protecting objects and cargo may be improved by using night vision systems. Such systems are not, however, being developed for the national economy. A monocular night vision instrument (the MPNV-1) has been developed for use in loading-unloading operations in railroad transport (during the dark portion of the day) and in protecting objects and cargo.

The instrument is distinguished by the presence of an assembly for the infrared illumination of the object under observation. This use is based on an ILPN-108-type semiconductor emitter and an economical power supply unit that uses the Bulgarian type 10KVM 05-12 storage battery, which is widely used on roads and which operates from Transport portable radio stations.

Components that are commercially produced on a wide scale are used in the instrument.

#### Technical Characteristics of Instrument

Observation range, m:	
During illumination by moonlight	300
During IR illumination in complete darkness, at least	100
Magnification of lens, X	2
Feed voltage, V	9-12
Required current, mA, not more than:	
By instrument	20
By infrared source	300
Mass, kg:	
Of electron-optical unit	1.2
Of power supply unit and accumulator	0.9
Range of operating temperatures, °C	-50 to +50

Figure 1 [not reproduced] shows a monocular night vision instrument consisting of an electron-optical unit (1) with an infrared illumination assembly (2) and a power unit (3). The casing protecting the lens and eyepiece from impacts and dirt has been removed from the electron-optical unit for visibility's sake.

An electron-optical converter that serves as an infrared radiation receiver is located in the metal casing of the electron-optical unit between the lens and eyepiece. A high-voltage voltage multiplier is located under the electron-optical converter. Its output is connected with the electron-optical converter, and its input, which is located on a cord (4), is connected with the power supply unit by a high-voltage cable.

The infrared source consists of a semiconductor emitter whose radiation wavelength corresponds to the "optical window" of the atmosphere and the focusing lens. The infrared source is connected with the power supply unit by a push toggle switch without clamping the wire on the core. The electron-optical unit's handle is hollow. It contains the optical receiver-transmitter's circuit.

The power supply unit consists of a casing, cover, and battery compartment. The battery switch and outlet of the electron-optical unit's feed cord are located on the cover. The voltage converter's transformer and a board with the circuits of the converter, the infrared illuminator's working current stabilizer, and the time interrupter to interrupt the converter's operation are located inside the casing. The structure of the battery compartment is hermetically separated from the rest of the casing and permits changing the battery from outside the power



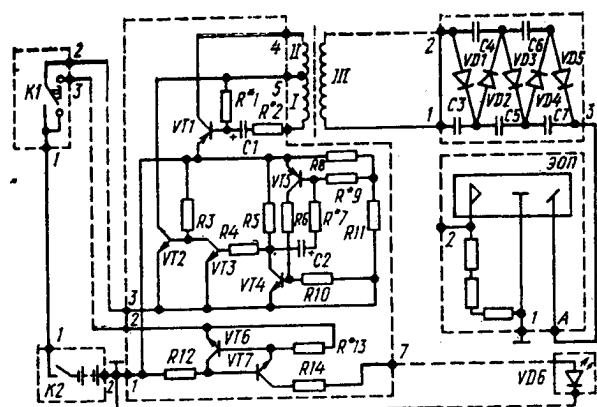


Figure 2. Electrical Circuit of Power Supply Unit and Connections of the Instrument

supply unit without disassembling it. The overall dimensions and mass of the power supply unit make it possible for the operator to keep the unit in his pocket under his clothing so as to reduce the battery's discharge during cold periods.

The power supply unit's electrical circuit (Figure 2) consists of the following functional assemblies: a primary current source, a voltage converter, an interrupter to interrupt the converter's operation, and a working current stabilizer for the infrared source.

The power supply unit operates as follows. When the toggle switch K2 is switched, voltage from the primary current source (the 10KVM 05-12 battery) enters the voltage converter, which is based on a self-excited oscillator circuit. Inside the self-excited oscillator, direct current is converted to alternating current.

Intermittent generation is created due to the condenser C1 in the circuit of the base of the triode VT1. During operation, the condenser C1 is charged from the feedback winding voltage by current passing through the emitter-base junction. The charging of the condenser occurs in positive half-periods corresponding to the increase in current in the collector winding. In the negative half-periods, the condenser cannot be overcharged since the feedback winding voltage will be applied to the emitter-base junction in a nonconducting direction. As soon as the condenser C1 is charged to a voltage of about 2.7 V, the generation ceases. This is because the triode is cut off by the positive potential of this capacitance, which is applied to its base.

The pause lasts until the condenser C1 (under the effect of the generator's output voltage) is recharged by the resistor R1 until the appearance of a voltage of about 1 V, which is applied as a minus to the triode base. The duration of the pause is determined by the sizes of the resistor R1 and the capacitance of the condenser C1. The duration of the pulses depends on the limiting resistor R1.

The alternating voltage of the first winding of the high-voltage transformer is increased in pulse by winding III to 5-6 kV and enters the high-voltage multiplier, which is based on five high-voltage diodes VD1-VD5 and condensers C3-C7. A rectified voltage of 18 to 23 kV, which is fed to the electron-optical converter, is produced at its output.

When the toggle switch K1 is turned off, the voltage from the primary current source enters the circuit of the infrared source's working current stabilizer, the voltage converter is offswitched, and the working current from the battery is reduced.

The current stabilizer is a multiplier with a direct connection that is based on the transistors VT6 and VT7.

The stabilization current is established by selection of the resistor R13.

The resistor R14 serves to protect the stabilizer during a short circuit in the load and to limit current inrushes through the emitter when it is switched on and off.

A time interrupter to interrupt the operation of the converter that switches the feed circuit from the voltage converter when the rated voltage is reached in the electron-optical converter and connects the feed circuit through the converter for the time interval in which the voltage in the electron-optical converter reaches the minimum allowable value is used to extend the battery's service life.

When the power supply is switched on by the toggle switch K2, voltage is fed to the circuit of the time interrupter, whose load serves as a voltage converter.

A voltage converter is included in the feed circuit in series with the transistor VT2. The condenser C2 is discharged; the transistor VT3 is closed; the transistors VT2, VT4, and VT5 are opened; and current flows through the load. The voltage converter will operate until the condenser C2 is charged to the voltage at which the transistor VT5 closes. The transistor VT3 opens, whereas VT4 and VT2 close. Current will not flow through the load, and the voltage converter will operate until the condenser C2 discharges the voltage at which transistor VT5 opens. After this, the time interrupter's operating cycle is repeated.

The voltage converter's operating time is determined by the value of the resistance of the resistor R7, and the pause time is determined by the resistance of the resistor R9; they generally amount to 10 seconds and 1.5 minutes. This makes it possible to reduce the working current to 20 mA, i.e., to achieve a five- to sevenfold reduction. When the toggle switch K1 of the infrared source is switched, the feed voltage is removed from the time interrupter to reduce the working current.

The personal-use monocular night vision instrument with infrared illumination that has been described increases the efficiency of loading-unloading and other jobs and protects objects during the nighttime and under conditions of limited visibility. The instrument's high sensitivity makes it possible to avoid additional illumination of objects, which saves electric power and reduces expenditures for laying power cables and installing projector masts.

The MPNV-1 may be used in those sectors of the national economy where work must be done under reduced illumination such as in the construction, civil

aviation, maritime and ore recovery industries, etc., as well as during work under polar night conditions and in unloading-loading, tunneling, and repair and restoration jobs. The instrument also makes it possible to assess damage related to accident situations in tunnels and in the basements of buildings. The instrument has been series produced since 1987 and operates reliably under various climate conditions. Its economic effect amounts to 130,000 rubles per year.

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**Seismoactive Zones of Southern Turkmenistan  
According to Geophysical and Structural-  
Geomorphological Data**

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[Text] The article examines the basic results of comprehensive analysis and structural-morphological, geophysical data. The analysis was undertaken with the goal of identifying zones of possible earthquake foci (VOZ zones) in the territory of the seismoactive mountain and foothill regions of Southern Turkmenistan. Much attention in this regard is given to the characteristics of microtectonics and seismicity of the neighboring territories across the border in Iran and Afghanistan (Elburs-Southern Kopetdag-Binalud and Khorasan-Parapamiz), which enables a broader approach to the evaluation of the identified VOZ zones.

The zones identified on the whole belong to a belt of actively forming alpine folding, for which various plicative deformations of the earth's crust are highly typical, as well as the southern portion of the epihercynian (Turanian) plate, with the undulating and blocklike tectonic deformations more typical of this region. This most common mechanism of the structural situation of such regions largely predetermines the principal regional peculiarities of the seismic regime, the manifestation of seismic dislocations in the structure of the earth's crust, and the relief of the earth's surface. From the data of seismological investigations [7, 10, 17, etc.], quite irregular distributions of the zones and individual sectors of active seismicity are found. However, the reasons for this phenomenon and the zones of possible earthquake foci have received insufficient study.

Accordingly, a study was made of the paramount morphostructural relief elements, the history of their development stage by stage, and the relationship with the deep-lying structure and the seismicity. Tectonically conditioned relief forms of the earth's surface were selected as the morphostructures. The mechanisms of the structure and formation of the morphostructures that were identified were considered as one of the symptoms of a more general seismological process.

**Conclusions**

The major role in the development of active seismic phenomena on the territory of Southern Turkmenistan and the contiguous mountainous regions of Iran and Afghanistan is played by processes of overthrusting of the Iranian plate onto the Turanian, as well as the

process of most recent activation (arching) of the alpine geosynclinal zone. These have taken place irregularly in time and in space, depending on the general alternation in the geotectonic regime and the structural differences of the territory.

According to the data of comprehensive analysis of the geophysical and structural-geomorphological materials, carried out in a historical-geological aspect, different types of zones of possible earthquake foci are identified. Belts of deep faulting and overthrusting, experiencing active vertical and horizontal tectonic shoving, are identified as zones of possible intense manifestation of seismic phenomena. Within the confines of these zones, sectors of possible localization of the active seismic phenomena are identified, mainly involving sectors of dysharmonic intersection of faults which appear in the relief.

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